STUDY OF SOFT STOREY TO SONSTRUCT EARTHQUAKE RESISTING STRUCTURE-REVIEW

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ABSTRACT

Soft storeys in a high rise building play an important role on its seismic performance. It is the one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above. In high rise building or multi storey building, soft storey construction is a typical feature because of urbanization and the space occupancy considerations. Such features are highly undesirable in buildings built in seismically active areas. This has been verified in numerous experiences of strong shaking during the part earthquake. Due to the considerations of occupancy and architectural appearance, especially in the entrance floor and on one of the intermediate levels, inner sections between columns and outer walls are not constructed in a way they are done in other storeys or rigidity of the single structure in the storeys are different. These sections in the buildings are generally used for sales stores, restaurants, bank branches, installations and lightening. These are labelled as soft storeys in literature. Most of the burden falls on soft storey.

1. INTRODUCTION

The Indian subcontinent has a history of devastating earthquakes. The major reason for the high frequency and intensity of the earthquakes is that the Indian plate is driving into Asia at a rate of approximately 47 mm/year. Geographical statistics of India show that almost 54% of the land is vulnerable to earthquakes. A World Bank & United Nations report shows estimates that around 200 million city dwellers in India will be exposed to storms and earthquakes by 2050. The latest version of seismic zoning map of India given in the earthquake resistant design code of India [IS 1893 (Part 1) 2002] assigns four levels of seismicity for India in terms of zone factors. In other words, the earthquake zoning map of India divides India into 4 seismic zones (Zone 2, 3, 4 and 5) unlike its previous version which consisted of five or six zones for the country. According to the in the field of seismology and allied disciplines.

Concept of soft storey.

A soft story building is a multi-story building in which one or more floors have windows, wide doors, large unobstructed commercial spaces, or other openings in places where a shear wall would normally be required for stability as a matter of earthquake engineering design. A typical soft story building is an apartment building of three or more stories located over a ground level with large openings, such as a parking garage or series of retail businesses with large windows.

2. LITERATURE REVIEW

Jaswant N. Arlekar, et al (1997)[1] research paper[1] have discussed the immediate measures to prevent the indiscriminate use of soft first storeys in buildings, which are designed without regard to the increased displacement, ductility and force demands in the first storey columns. Alternate measures, involving stiffness balance of the open first storey and the storey above, are proposed to reduce the irregularity introduced by the open first storey. The effect of soil flexibilityThe upper storeys have brick infilled wall panels. The draft Indian seismic code classifies a soft storey as one whose lateral stiffness is less than 50% of the storey above or below they have used IS 1893,1997. They studied many earthquakes in past eg San Fernando 1971, Northridge 1994, Kobe 1995,have demonstrated the potential hazard associated with such buildings. Major damage to many reinforced concrete and steel buildings in the Hyogoken-Nanbu earthquake of January 17, 1995, and to critical hospital facilities in the San Fernando earthquake of 1971.

Dr. Mizan DOGAN, et al 2002 research paper[2].

have focused on the investigations on soft storey conducted in quake region of Izmit and Duzce, was on the investigation of effect of soft storey on the behaviour on the construction. Also solutions were investigated for making soft storeys in the present constructions and in the ones to be built resistant to quake. It covers the studies that were conducted in the quake area of Izmit (Mw= 7.4, August 17, 1999) and Duzce (Mw= 7.2, November 12, 1999). They have concluded the study with drawbacks and stages of preventing of soft storeys. They have surveyed the structures which were damaged due to earthquakes in Izmit and Duzce, they found out that nearly 85-90% of the collapsed and damaged buildings had soft storeys in them.

Bing Li1 and Tso-Chien Pan, et al 2004 research paper[3] have discussed a region of low to moderate seismic risk and low wind speed, such as Singapore and Malaysia, buildings with relatively weak lateral structural resisting system are likely to represent a large portion of the building inventory The main objective of this paper is to strengthen the need to look into the seismic performance of some typical existing and prospective reinforced concrete frame structures designed in Singapore under low seismic loading. The performance of the structures is checked through a non-linear dynamic analysis. They have done an experimental program for a subassembly (beam-column) test program was developed to assess the significance of the perceived concerns on the post-yield behavior of buildings designed. Two full-scale models of the prototypical subassembly were constructed and tested by Li in the heavy structure laboratory of the Nanyang Technological University. The beam-column joints were tested subjected to quasi-static load reversals that simulated earthquake loading.

Sharany Haque, et al 2008 research paper[4] was study is all about the effect of masonry infill in the upper floors of a building with an open ground floor subjected to seismic loading. In this study the amount of infilled panels is taken as no infill condition (zero percent infilled panels / bare frame) and 50 percent infilled panels on the upper floors. Also to see the effect of number of floors, a 9 storied and a 12 storied building is also studied in addition to a six storied building. They have studied different types of models for open ground story in the analysis of the complete bare frame.Comparison of base shear is done. Base shear is a very important parameter for earthquake resistant design of buildings. In the present study, shear developed at the base of the building due to response spectrum load for no infill condition and 50% infill condition has been evaluated and compared for six, nine and twelve storied building.

Mehmet et al 2008 research paper[5] was investigates soft story behavior due to increased story height, lack of infill mount at ground story and existence of both cases using nonlinear static and dynamic response history analyses for mid-rise reinforced concrete buildings. Displacement capacities at Immediate Occupancy, Life Safety and Collapse Prevention performance levels and story drift demands of the regular and soft story models are determined. Effect of infill walls on structural behavior, especially for the soft story, is investigated in order to increase the level of knowledge and awareness on the subject. Soft story behavior due to change in story height and/or infill amount is evaluated in view of these displacement capacities, drift demands and structural behavior. This study aims to investigate soft story behavior using nonlinear static and dynamic response history analyses for mid-rise RC buildings which are thought to be the most vulnerable in existing building stock. Three-dimensional model of each structure is created in software to carry out nonlinear static analysis. Beam and column elements are modeled as nonlinear frame elements with lumped plasticity by defining plastic hinges at both ends of beams and columns. As shown in Figure, five points labeled A, B, C, D, and E define force-deformation behavior of a plastic hinge. Soft story behavior due to increased story height, lack of infill wall amount at ground story and existence of both cases is investigated using nonlinear static and dynamic response history analyses for mid-rise reinforced concrete buildings. When the obtained displacement capacity and drift demand results are evaluated, in scope of the values considered in the study, it is observed that soft story due to increased height (SSH) and due to lack of infill walls (SSW) have close values to each other. As a result, it should be kept in mind that soft story may arise not only because of

increased story height, but because of abrupt changes in amount of infill walls which are not thought to be a part of structural system. As observed in this study, soft story due to both increased height and lack of infill wall at ground story is the most detrimental case in view of drift capacities and demands.

M. R. Amin et al 2011 research paper[6] have discussed about the seismic performance of 3D building frame with intermediately infilled frame was studied. Performance of R.C. frame was evaluated varying storey level and location of soft storey. The main objective of the study was to investigate the behavior of multistory, multi-bay soft storey infilled frames and to evaluate their performance levels when subjected to earthquake loading. In this investigation, earthquake load was chosen as a source of lateral loading on a building frame as set forth by the provision of Bangladesh National Building Code (BNBC, 1993). They have created four building models of varying storeys (3, 6, 9 and 12 storey) with identical building plan and were analyzed. The frame members were modeled with rigid end zones, the walls were modeled as equivalent diagonal struts in place of masonry to generate infilled effect. Linear elastic analyses of the building were carried out using the equivalent static method. They have calculated Lateral drift and Inter-storey drift of four models and have plotted the graph according to its results. They came to conclusion that lateral drift is maximum at the middle portion of building and decreases at the lower and top floor. Also Inter-storey drift ratio was showing parabolic graph indicating that drift is maximum at the middle stories and was found independent of soft storey location and building height but for any particular floor level maximum value was obtained when that particular floor level was kept open.

Nurjaman, H.N. et al 2012 research paper[7] have discussed Design, Testing and Strengthening of Soft Storey of Multi-storey Low Cost Housing in Indonesia with Precast Concrete Frame System in Indonesia many buildings experienced severe damages due to soft storey effect. This effect was emerged as a consequence of discarding additional stiffness supposedly contributed by masonry wall to structural precast concrete frame overall stiffness in structural design .they have studied experiences in 2006 yogya and 2007 west sumatra earthquakes . Geologically, Indonesia located at a region in equatorial hemisphere where several tectonic plates are collide, so as to make Indonesia susceptible to strong earthquake motions, as seen in Indonesian earthquake map in Figure. Since Aceh earthquake, there were series of major earthquakes in Indonesia, such as Yogyakarta earthquake and West Sumatera earthquake. In the two events, many buildings experienced severe damages due to soft storey effect.

Dr. Saraswati Setia et al 2012 research paper[8]was present analytical study investigates the influence of some parameters on behavior of a building with soft storey. The modeling of the whole building is carried out using the computer program STAAD Pro 2006. Parametric studies on displacement, inter storey drift and storey shear have been carried out using equivalent static analysis to investigate the influence of these parameter on the behavior of buildings with soft storey. In the present work a typical 6 storied RC frame building is being modeled using the computer software STAAD PRO. 2006. The selection of building configuration is basically done as per IS: 456, 2000 and the loading details are taken as per IS: 875, 1987 part1 & part2. Equivalent static analysis is performed for five different models by using the computer software. Model-1 is a bare frame. In model-2 masonry infill panels are introduced in upper floors, model-3 is similar to model-2 with only difference that column size of ground storey is increased by 62% of model-2. Shear walls are introduced in central core and outer periphery in model-4 and 5 respectively to minimize the soft storey effect. Minimum displacement for corner column is observed in the building in which a shear wall is introduced in X-direction as well as in Z-direction. But in case of intermediate column, displacement is minimum in building having masonry infill in upper floors and with increased column stiffness of bottom story in comparison to the building with shear wall in X-direction as well as in Z-direction. Buildings with shear wall in core and shear wall in X-direction as well as in Z-direction have uniform displacement because of shear wall. Which shows a gradual change of stiffness between the lower soft storey and the upper floors that is essentially required.

Teresa Guevara-Perez et al 2012 research paper[9] mentioned that though Soft story and Weak story are aesthetical and functional but are significant source of serious earthquake damage. They are called irregular building configurations and are essentially originated due to architectural decisions. They have been long recognized by earthquake engineering as seismically vulnerable. This paper analyses the architectural reasons why these configurations are present in contemporary cities and explains in conceptual terms their detrimental effects on building seismic response. In architectural terms soft story and weak story are both known as the open floor. The results of studies that establish the link between the open floor architectural configuration and the effects produced by earthquakes on buildings with this configuration have been restricted to the academic and professional field of structural engineering, while architects and urban planners have continued to widely apply these modern pattern, not understanding the interdependence between their decisions and the generation of seismic vulnerability that they produce in contemporary cities. In the late 20th Century, the buildings damaged by the earthquake were identified by specialists and their cause was the presence of weak story and soft story. Two new types of irregularities were introduced to the table of irregularities in elevation as Extreme Soft Story and Extreme Weak Story. These concepts,

soft story and weak story, are often mistaken for each other, and sometimes even used interchangeably, although each one of them is related to a different physical feature of the structure: the soft story or flexible story, with the difference of stiffness (resistance to deformation), between one building floor and the rest; and the weak story, with the difference of lateral strength or resistance to earthquake forces, between one building floor and the rest. These irregularities may be present simultaneously and each of them could be on the first story or at an intermediate level. The open floor configuration is an architectural design feature that will not be easy to eliminate from architects design criteria. It gives to the designer a series of functional and aesthetic advantages that are encouraged in schools of architecture and urban planning. But, it has been recognized by worldwide specialists in structural engineering, that this architectural configuration leads to the formation of soft and weak story irregularities, when not treated in a special way could produce severe structural damage and even the collapse of buildings when an earthquake occurs.
N. Sivakumar et al 2013 research paper[10] have studied and suggested that the design of the columns of the open ground floor would be safer if these are designed for shear and moment twice the magnitude obtained from conventional equivalent static force method. Study of the sway characteristics also reveals significantly high demand for ductility for columns at ground floor level. Presence of in filled wall on upper floors demands significant enhancement of column capacity or ductility to cope up with increased sway or drift. An investigation has been performed to study the behavior of the columns at ground level of multistoried buildings with soft ground floor subjected to dynamic earthquake loading. The structural action of masonry infill panels of upper floors has been taken into account by modeling them as diagonal struts. Finite element models of six, nine and storied buildings are subjected to earthquake load in accordance with equivalent static force method as well as response spectrum method. For the modeling of the six and nine storey structure, line element was used for beams and columns and concrete element was used for slabs. The base of structure was fully fixed by constraining all the degrees of freedom. A six storey RC building in Zone III on medium soil was analyzed and the shear forces, bending moment's axial forces, mode shapes around the structure due to different load combinations were obtained. Seismic analysis was performed using Equivalent lateral force method and response spectrum method given in IS 1893:2002.
Base shear is a very important parameter for earthquake resistant design of buildings. In the present study, shear developed at the base of the building due to response spectrum load for no infill condition and 50% infill condition has been evaluated and compared for six and nine storied building.

3.CONCLUSION

In this research review paper soft story effect discussed in brief. The infill wall attempt various researcher but they are reduce the soft story effect. Scope of work reduce dynamic action of soft story. The researcher focus on combination of measure adopted on the structure to reduce effect through seismic and dynamic action analysis. The parameter studied in this researcher are story drift, axial & shear force, bending moment, displacement. In his researcher also discuss effect of infill wall and the perform of effect of building. The got the conclusion soft story effect theoretically and factually caused by many building different seismic event in the world. The open floor configuration architectural design feature that will not be easy to eliminate architect design criteria. This lead to formation a soft story irregularities when it not be treated special way would produce structural damage and even the collapse of building at earthquake. The first story the effect of soft story is consider then the deflection has increases at that particular floor. In RC frame building with open first floor are known to perform poorly during in strong earthquake shaking son to improve the capacity of column during earthquake shaking, there is the scope of work .

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